Mapping high sea winds from space

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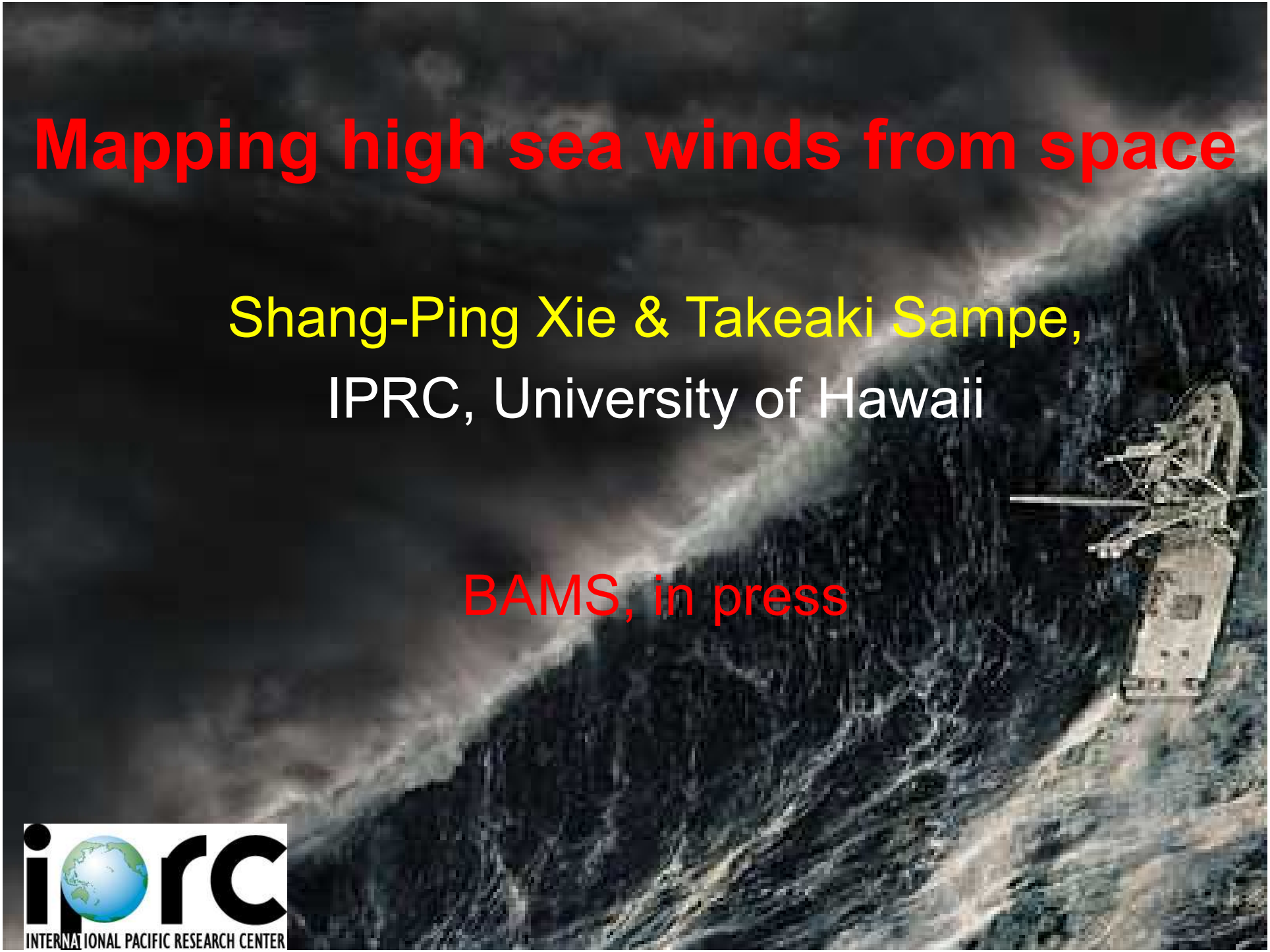
BAMS, in press



INTERNATIONAL PACIFIC RESEARCH CENTER

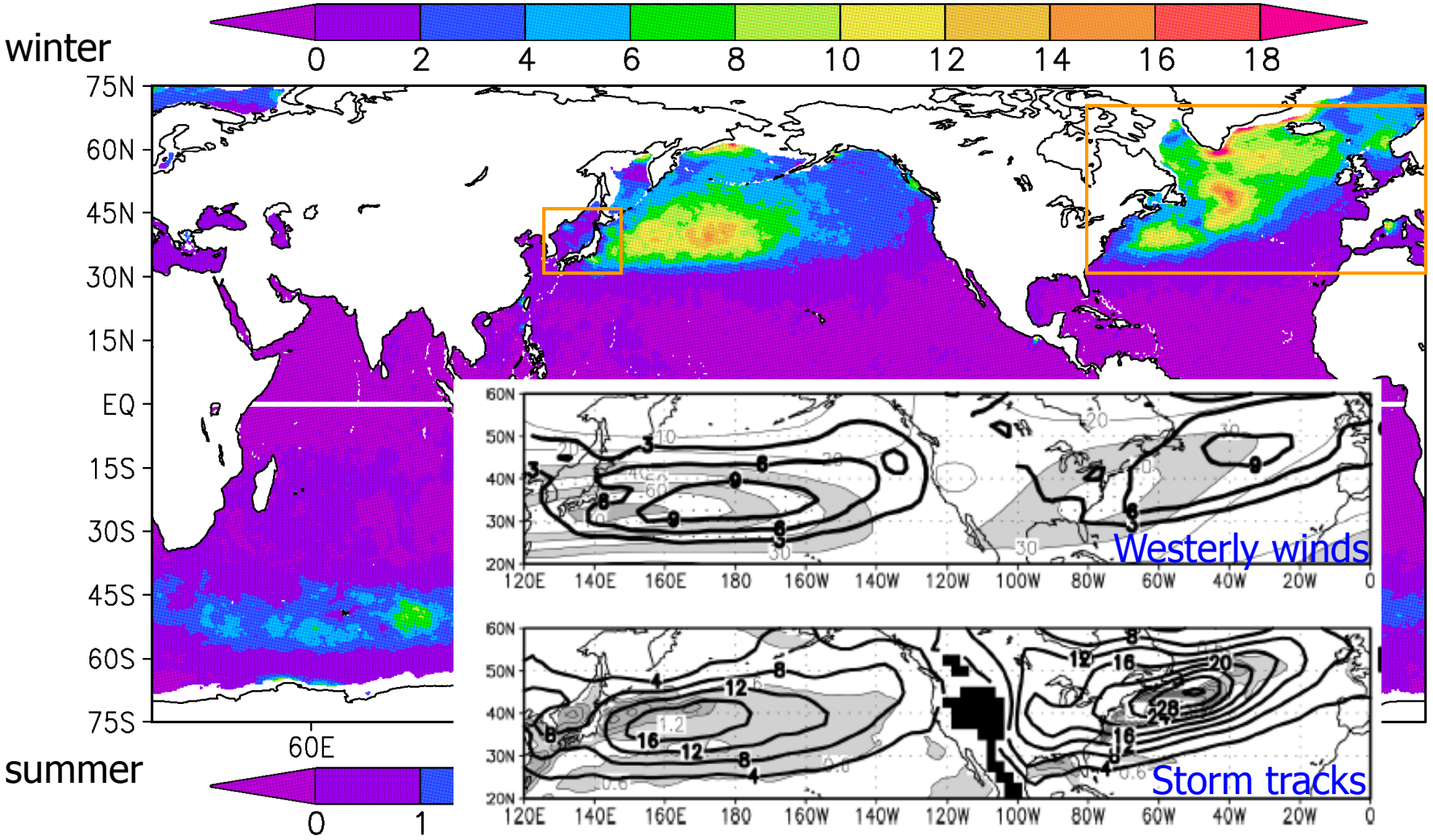
High Sea Winds

- danger to ships
- intense air-sea exchanges
- enhance upper ocean mixing

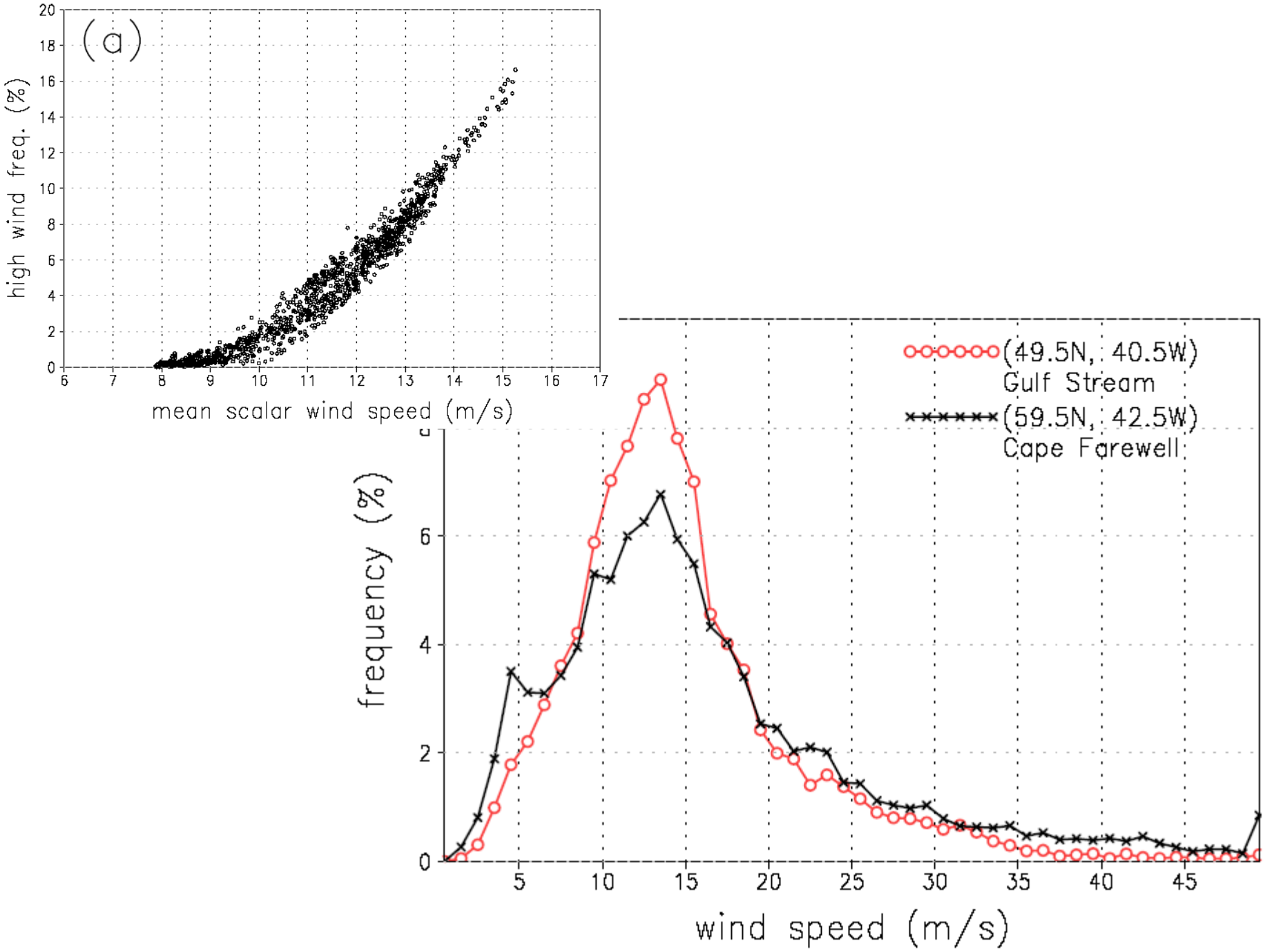
✓ Global mapping of high-wind (**>20 m/s**) occurrence using QuikSCAT for 7 years (Sept 1999 – Aug 2006).

Dec-Jan-Feb

- frequent in wintertime midlatitudes (storm track region)
- less in the (sub-) tropics

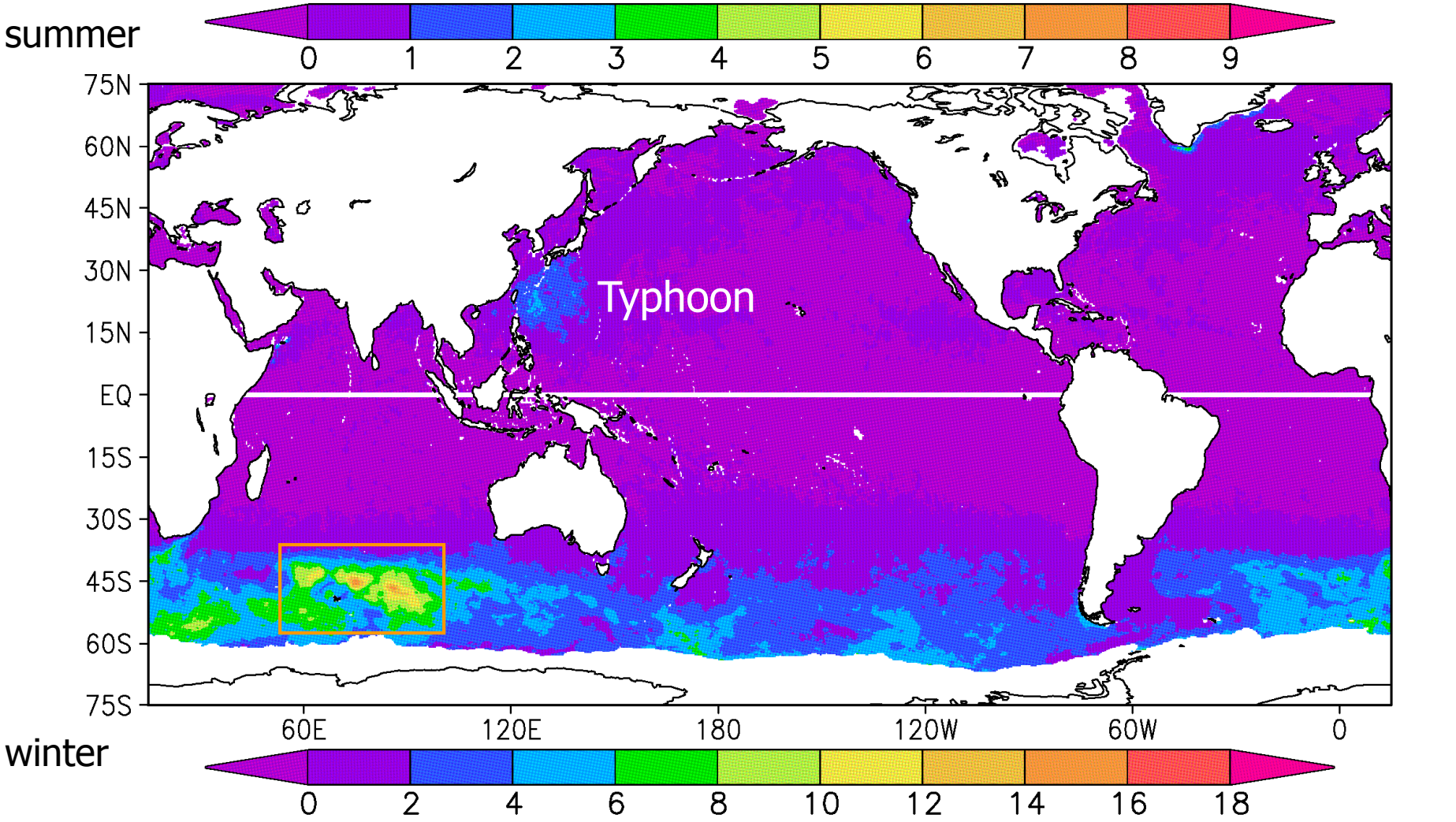


Color: High wind frequency (%)

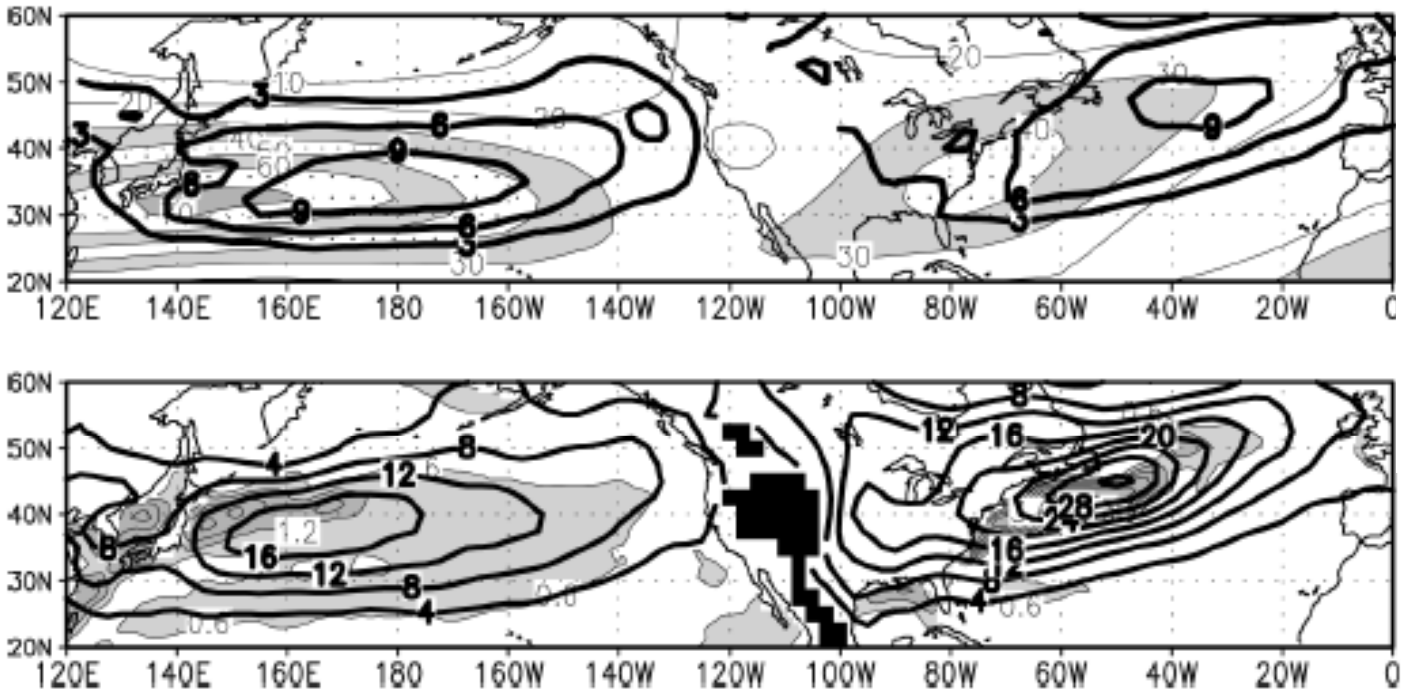

(a)
high wind freq. (%)
mean scalar wind speed (m/s)
(49.5N, 40.5W)
Gulf Stream
(59.5N, 42.5W)
Cape Farewell
frequency (%)
wind speed (m/s)

Jun-Jul-Aug

- Tropical cyclones do not emerge in climtology



Color: High wind frequency (%)



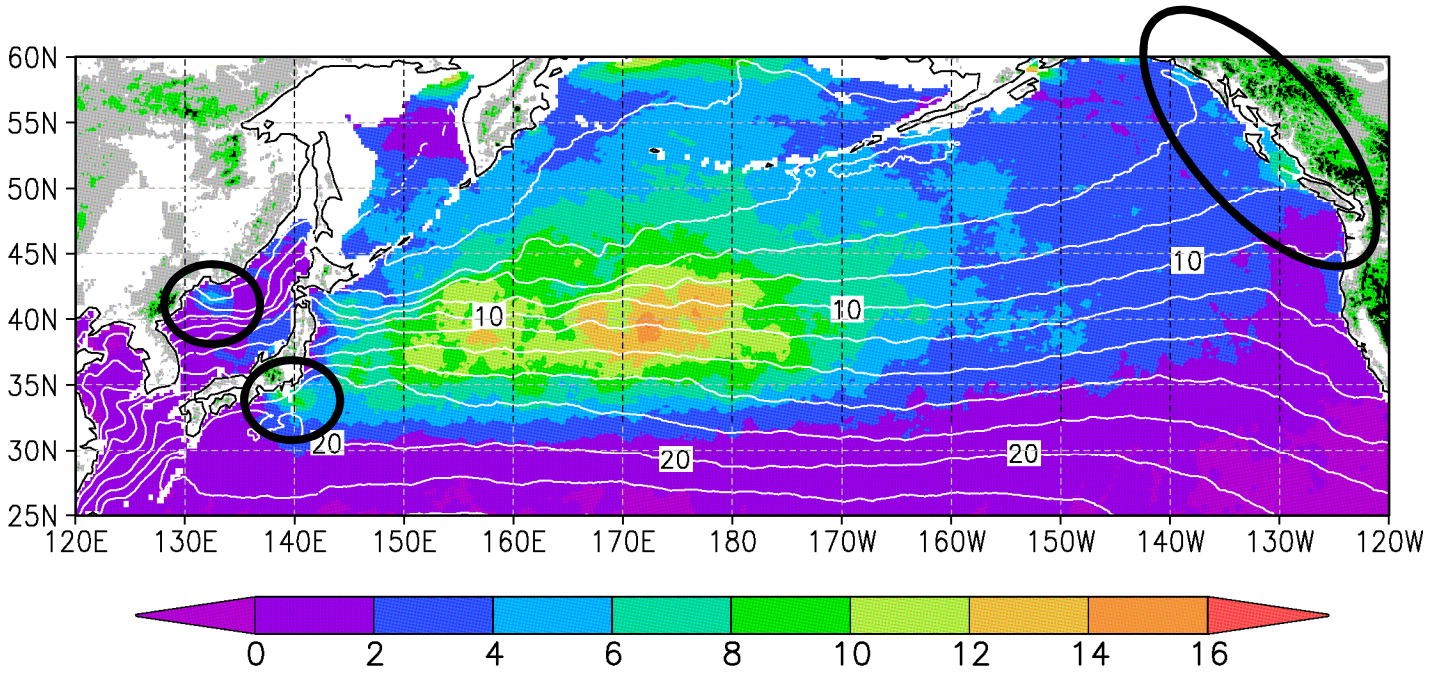
← zonal wind

← low-level storm track

Figure 6. (a) Climatological Jan.~Feb. distribution of 925-hPa U (heavy lines for every 3 m s^{-1}) and 250-hPa U (light and heavy stippling for 30~40 and 50~60 m s^{-1}, respectively), based on the NCEP reanalyses. (b) As in (a) but for 850-hPa poleward eddy heat flux (heavy lines for every 4 K m s^{-1}). Light and heavy stippling indicates oceanic frontal zones where meridional SST gradient (°C/110 km) is 0.6~1.2 and above 1.2, respectively (with thin lines for every 0.6), based on the data by *Reynolds and Smith* [1994].

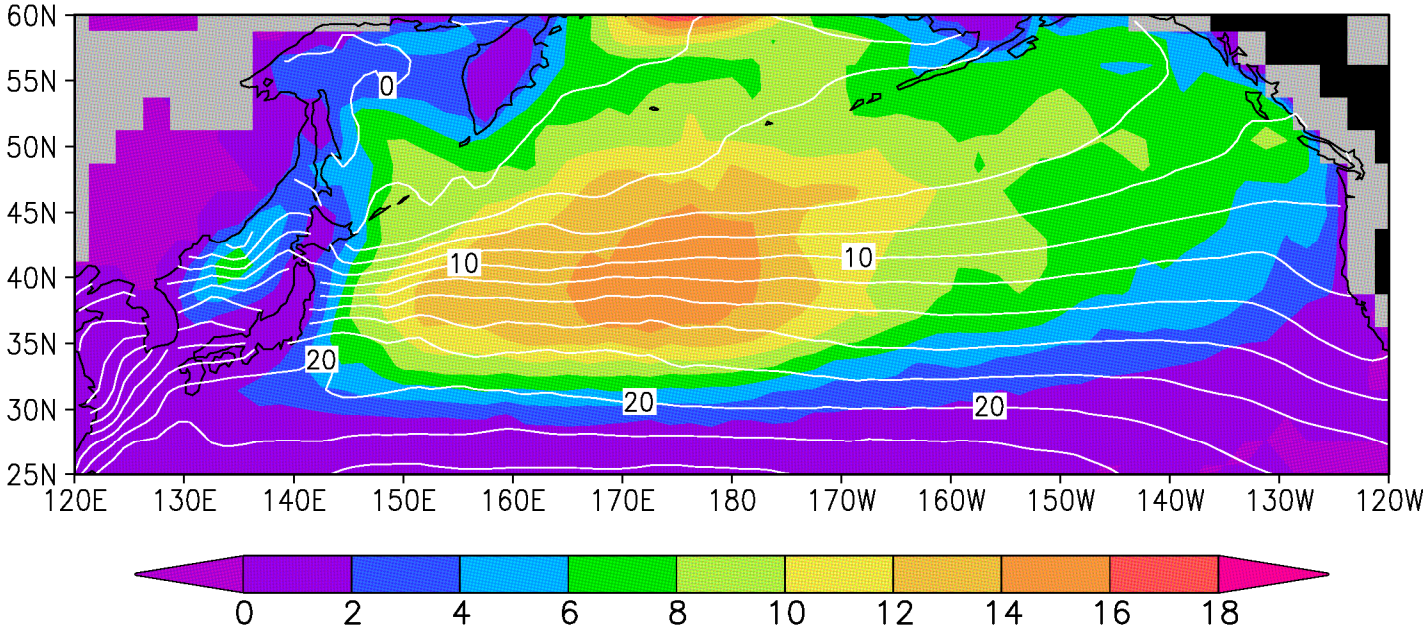
NCEP/NCAR reanalysis (Nakamura et al. 2004)

Winter North Pacific

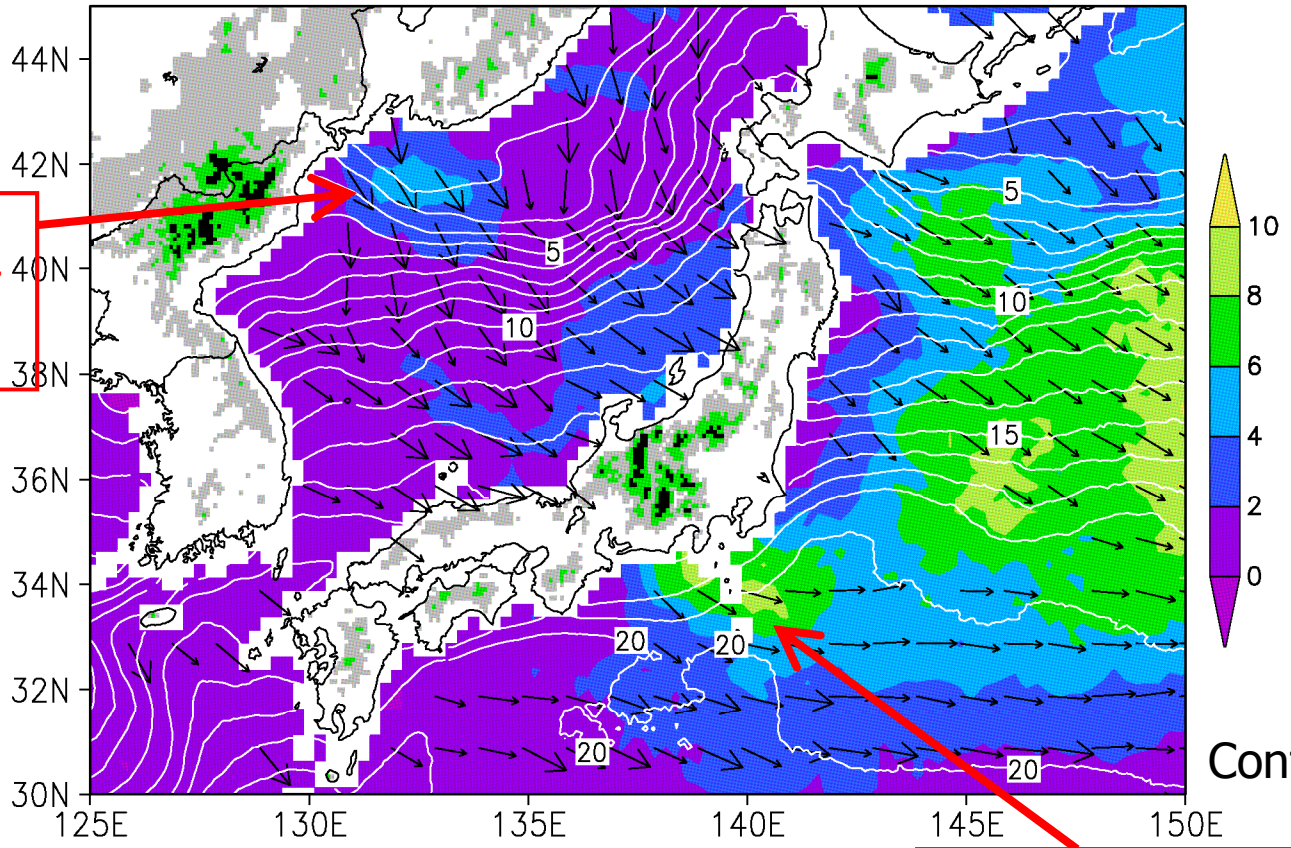


SST influence is not clear (front is not so sharp).

several orography-related features


60N
55N
50N
45N
40N
35N
30N
25N
120E
130E
140E
150E
160E
170E
180
170W
160W
150W
140W
130W
120W
0
10
10
20
20
20
0
2
4
6
8
10
12
14
16
18

Around Japan



cold air outbreaks off Vladivostok

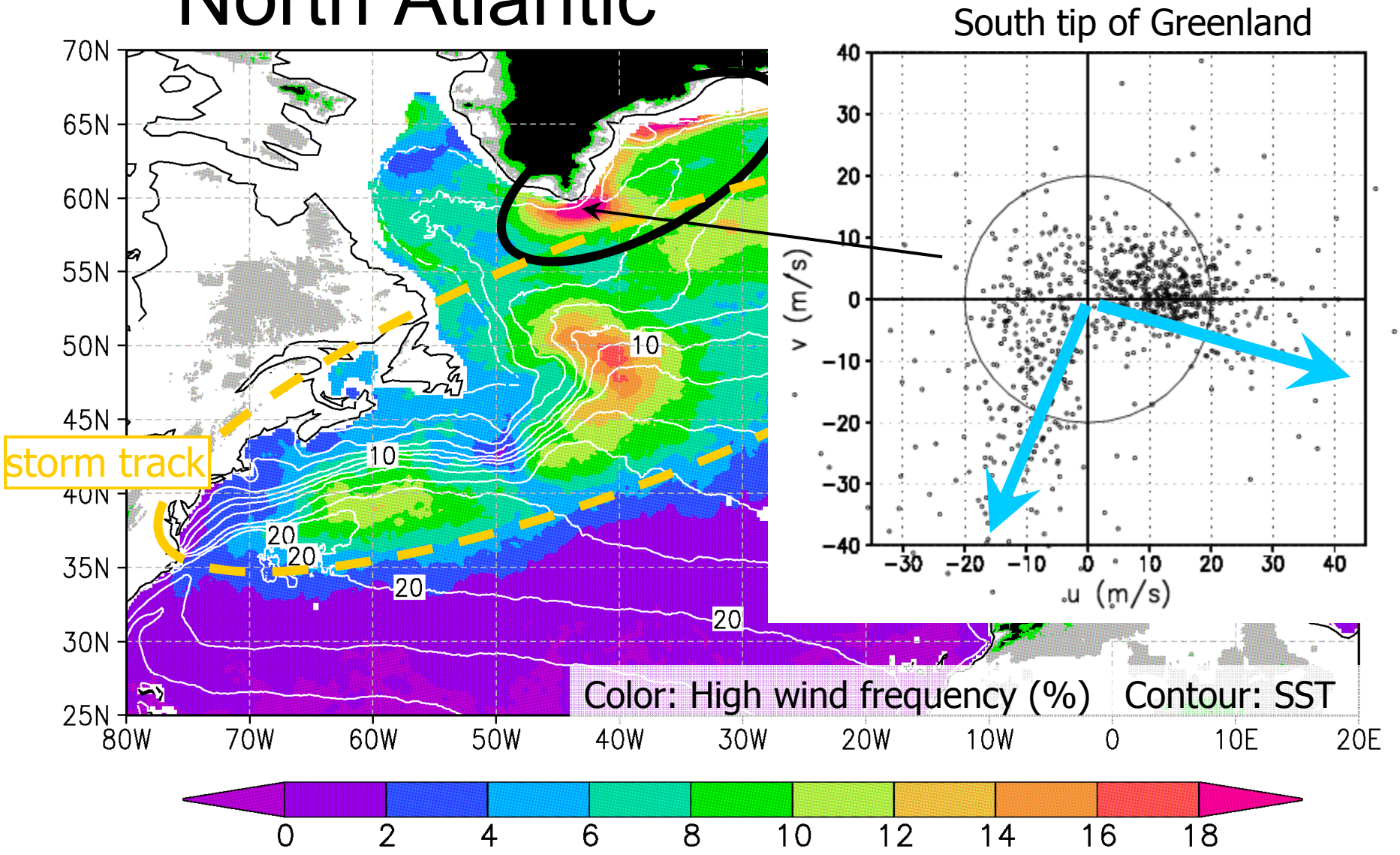
Contour: SST

- high-wind spots, associated with orography

$\overrightarrow{20}$

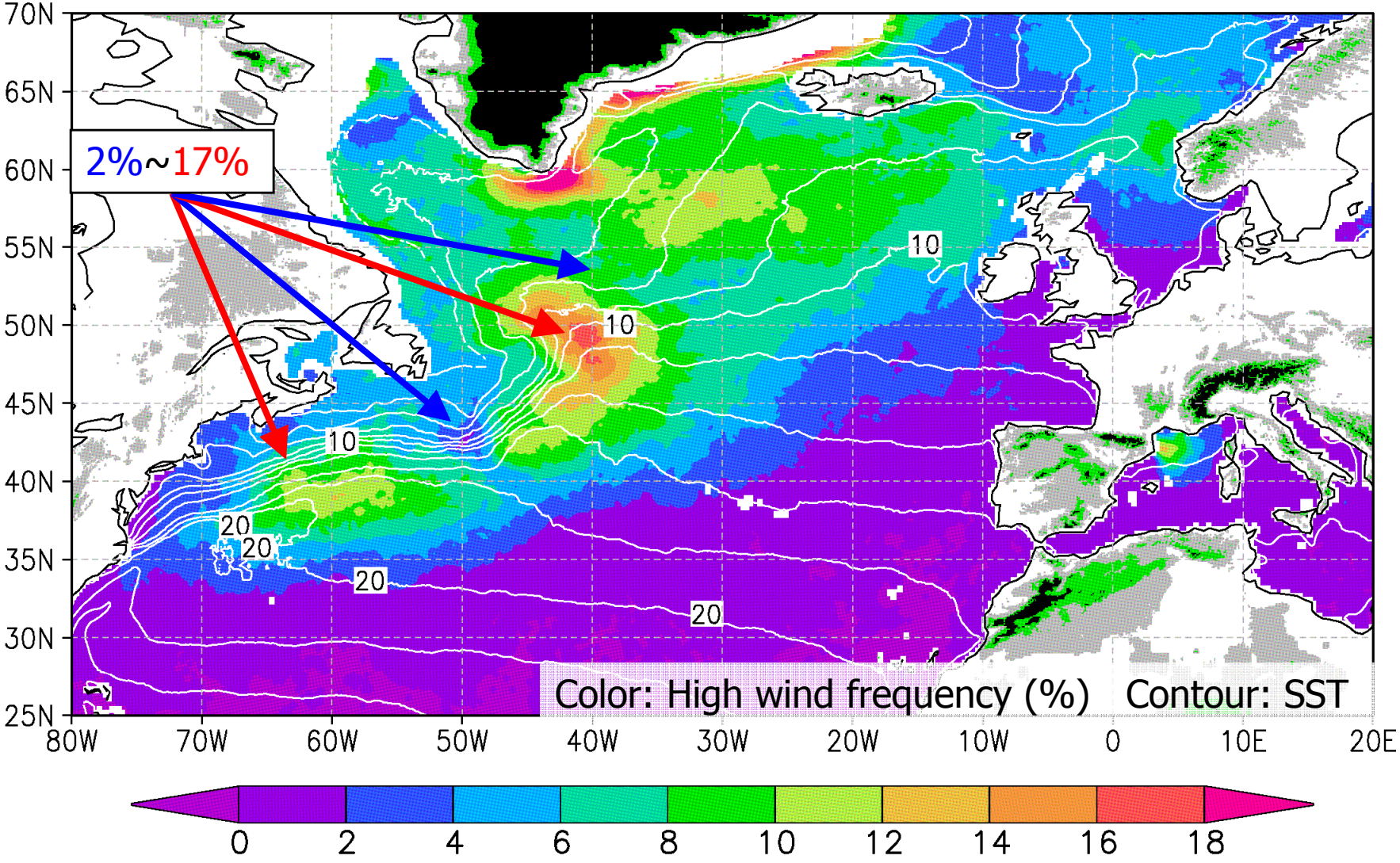
Strong westerly wind after passage of low (to the east of max. in mean winds)

North Atlantic



- Orography (Greenland, Norway, France-“mistral”)
- SST frontal effects (more frequent over warmer waters)

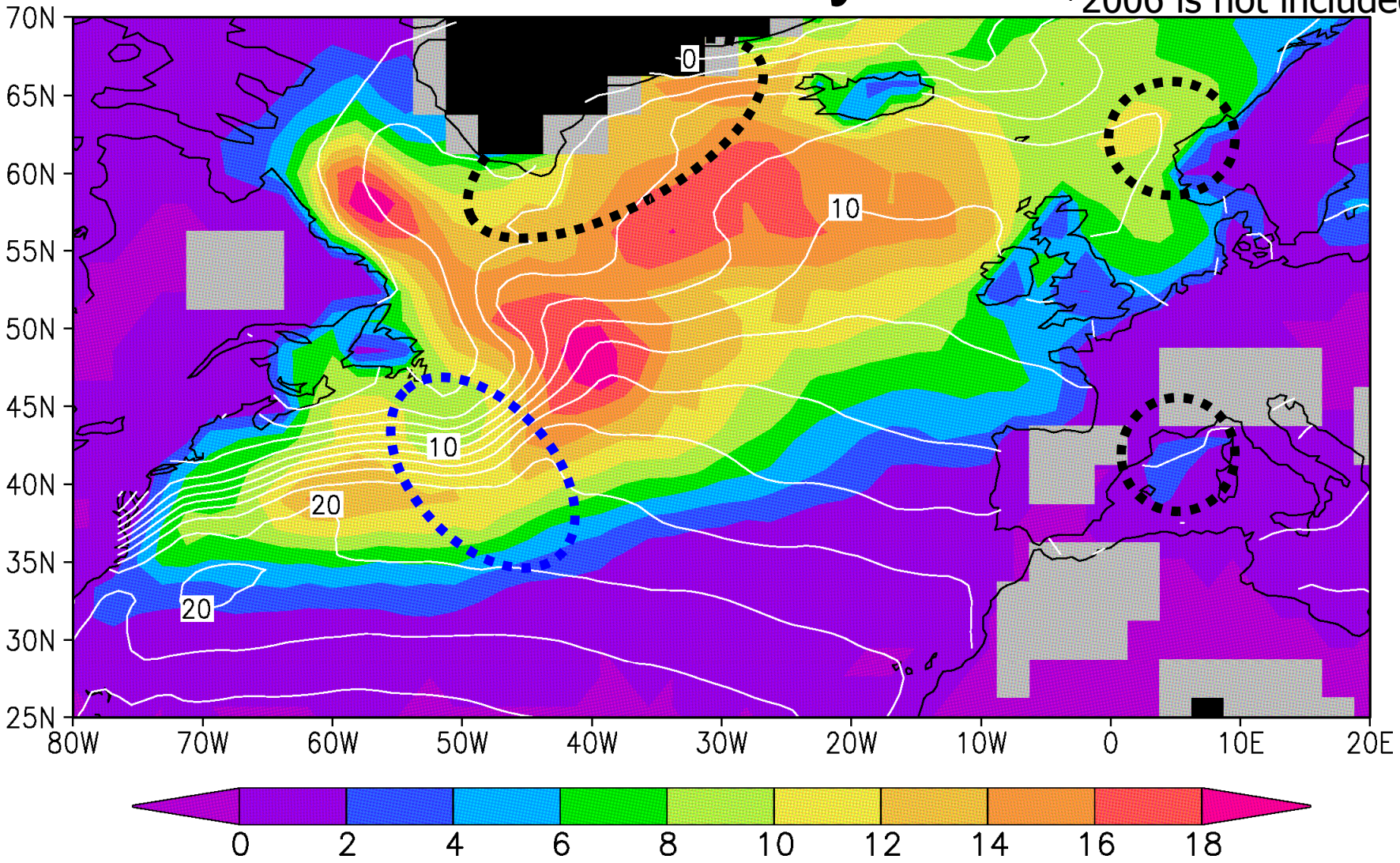
North Atlantic



- Orography (Greenland, Norway, France-“mistral”)
- SST frontal effects (more frequent over warmer waters)

NCEP reanalysis-2

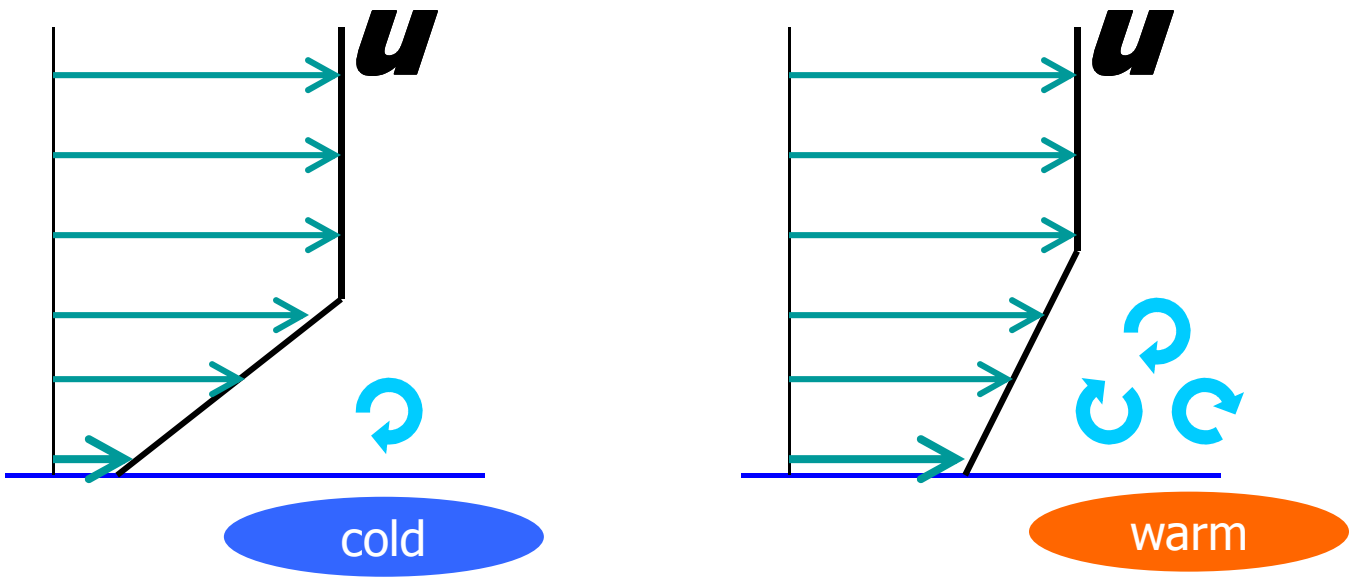
*2006 is not included



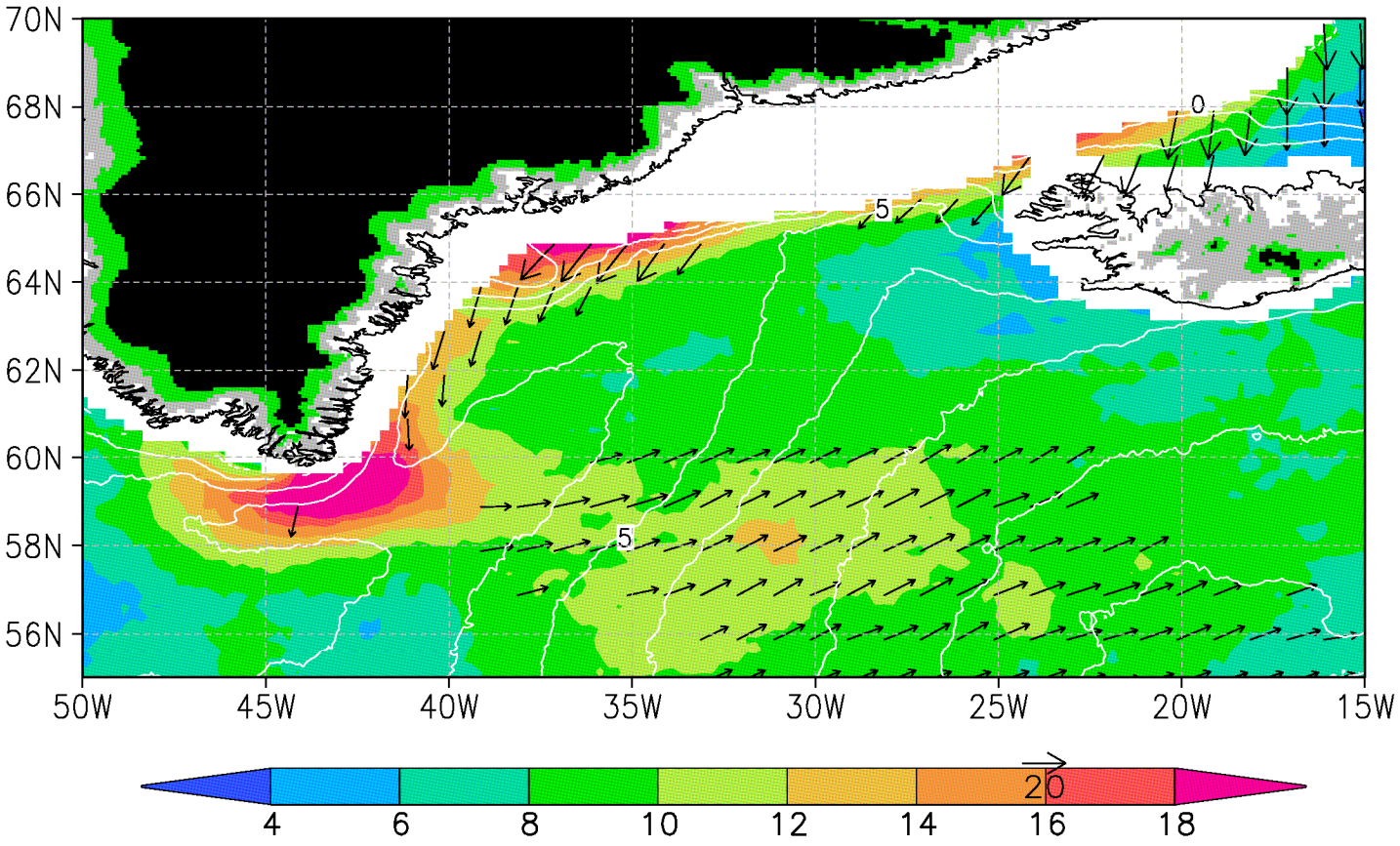
- orography-related features are not captured well
- SST impact is not clear (land-sea contrast is conspicuous)

momentum-mixing mechanism

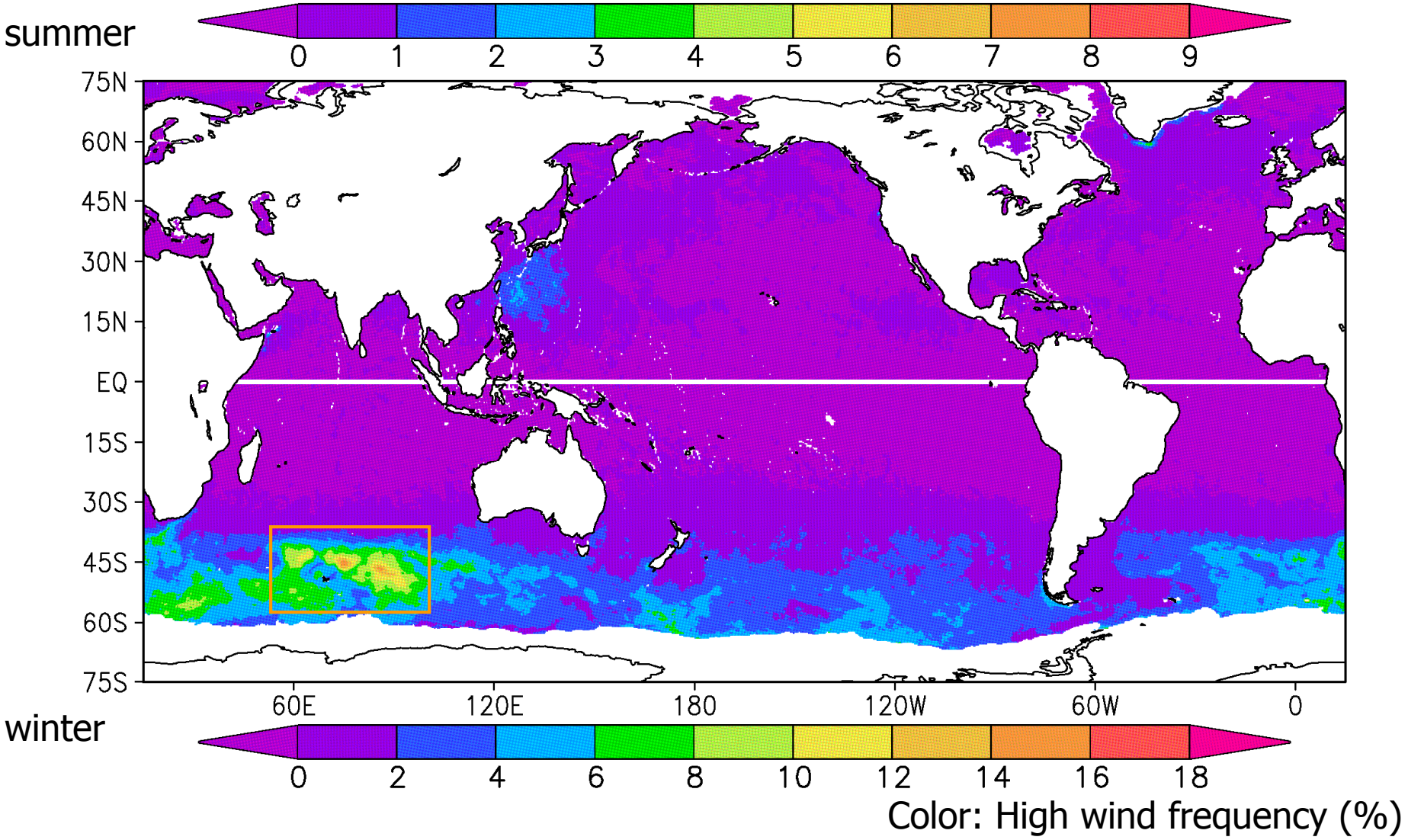
- lower static stability over warmer waters → enhanced mixing → increase in downward transport of momentum to the surface. (Wallace et al. 1989 etc.)



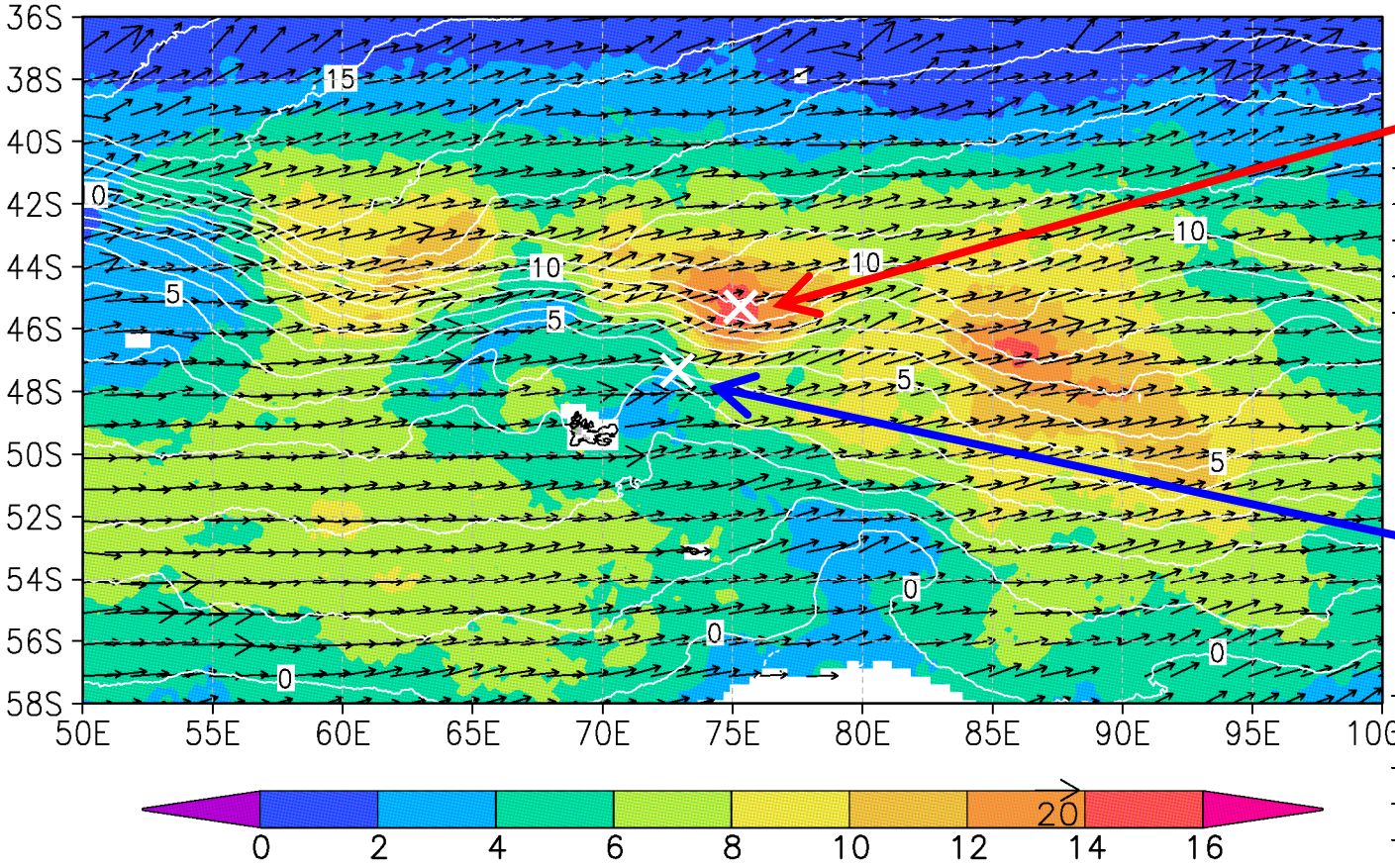
off Greenland



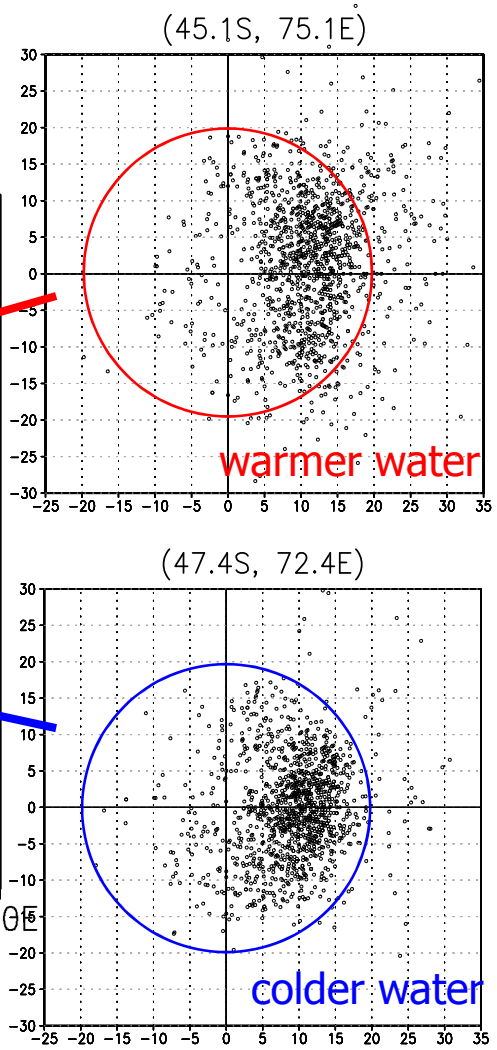
JJA


summer
0 1 2 3 4 5 6 7 8 9
75N
60N
45N
30N
15N
EQ
15S
30S
45S
60S
75S
60E
120E
180
120W
60W
0
winter
0 2 4 6 8 10 12 14 16 18
Color: High wind frequency (%)

Southern Indian Ocean



Color: High wind frequency (%) Contour: SST



daily wind vector (u,v)

Top 10 list for frequent high winds

(annual mean)

Blue: Orographic; Red: SST fronts; Gray shade: near ice edge

	frequency (%)	position	name
1	16.4	59°N 43°W	Cape Farewell, Greenland
2	11.6	65°S 52°E	Enderby land, Antarctica
3	11.5	65°N 36°W	E. coast of Greenland
4	10.3	68°N 22°W	Denmark Strait
5	10.0	55°S 3°E	Bouvet Island, S. Atlantic
6	7.9	47°S 86°E	S. Indian Ocean
7	7.6	45°S 76°E	NE of Kerguelen Isl., S. Indian Ocean
8	7.5	56°S 68°W	Cape Horn
9	6.9	51°N 44°W	N. Atlantic
10	5.9	43°S 64°E	NW of Kerguelen Isl., S. Indian Ocean

High wind occurrence

QuikSCAT satellite reveals rich variability of high winds.

- Basin scale: storm tracks and the westerlies
- Sub-basin scale: SST and orography
  - spatial variations across oceanic fronts
  - more (less) over warmer (colder) waters
  - coastal orography (cape wind, gap wind)

Sampe and Xie, BAMS, accepted. Preprint, data and images available at

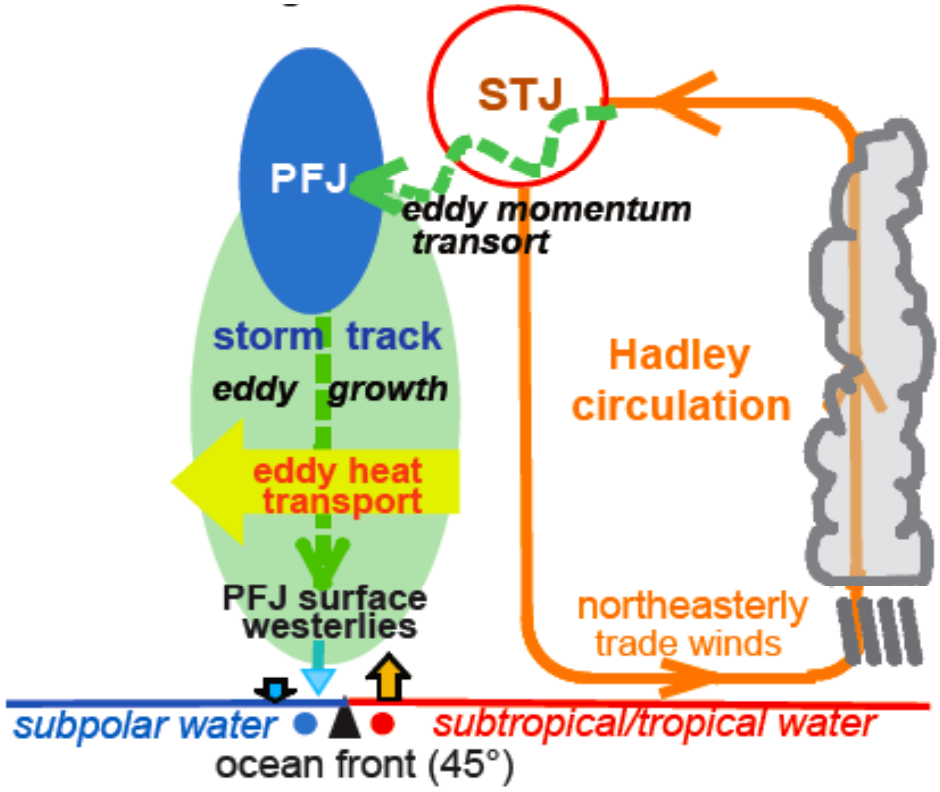
http://iprc.soest.hawaii.edu/~takeaki/highwind/index.html

Why do high winds occur near major ocean fronts?

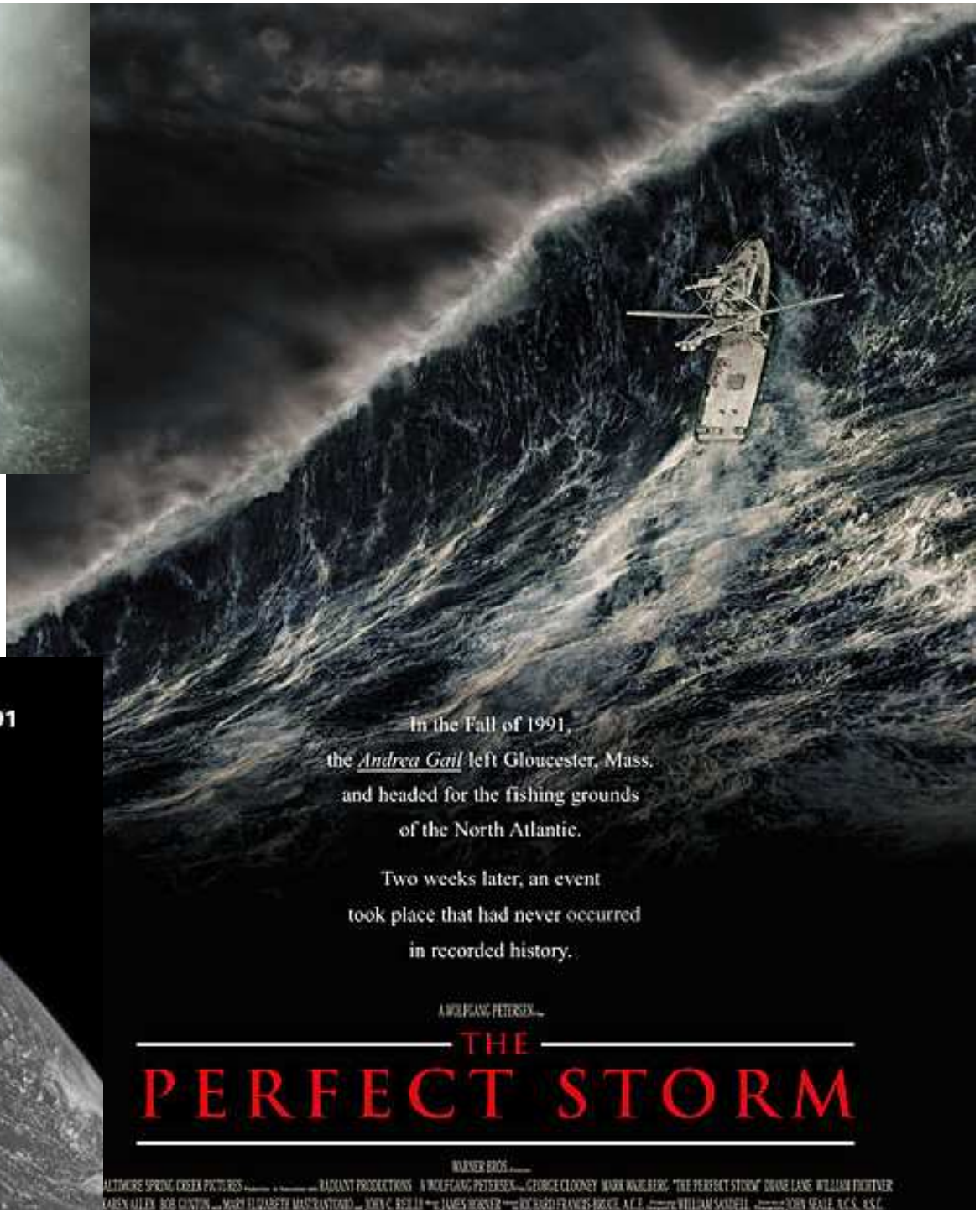
Ocean front

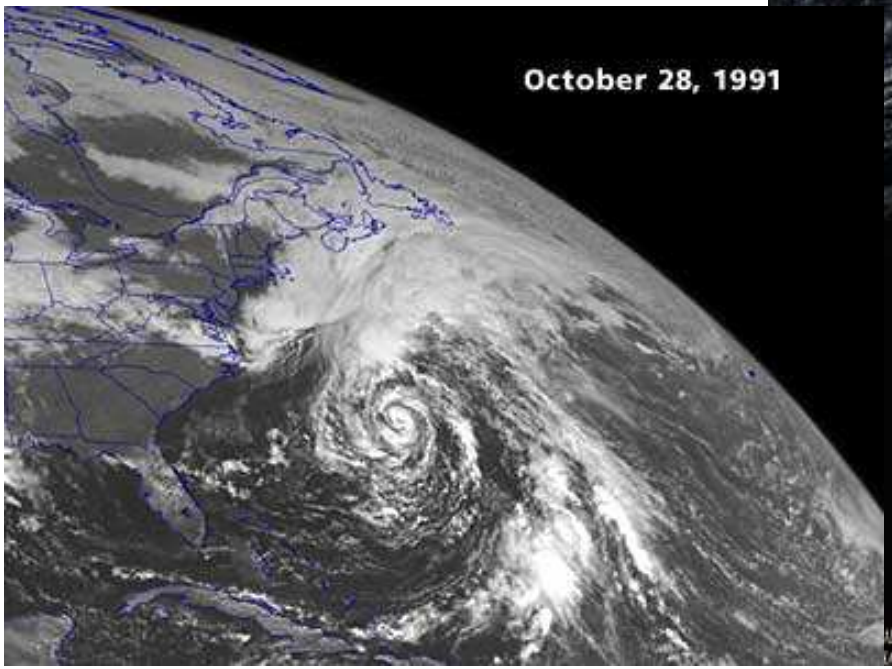
Storm growth & surface westerlies

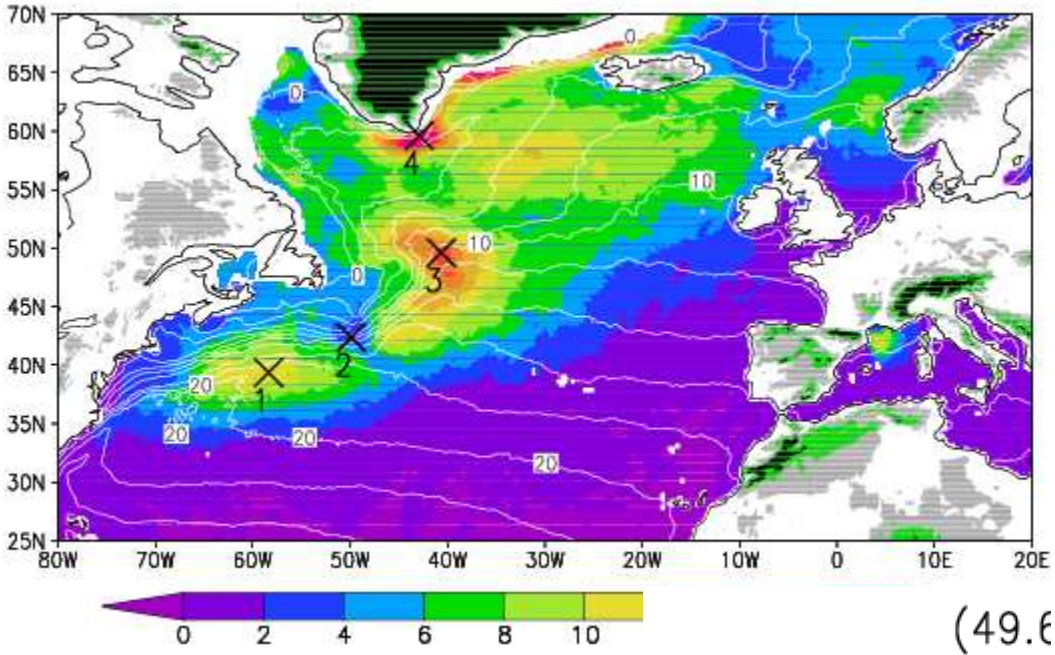
Surface stability

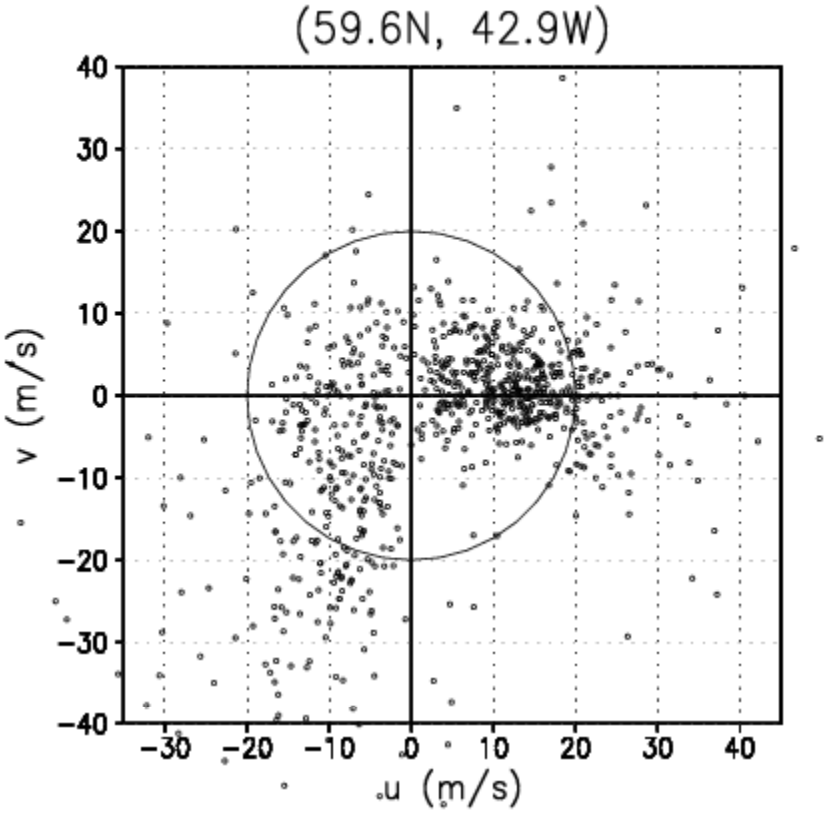


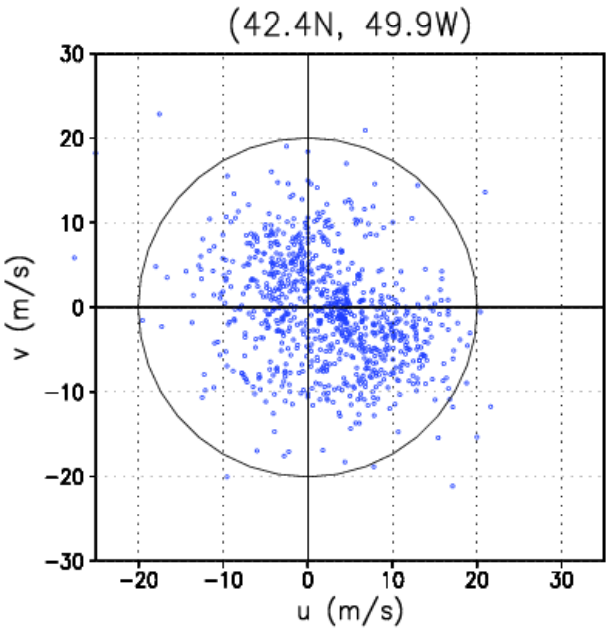
Nakamura et al. (2004)

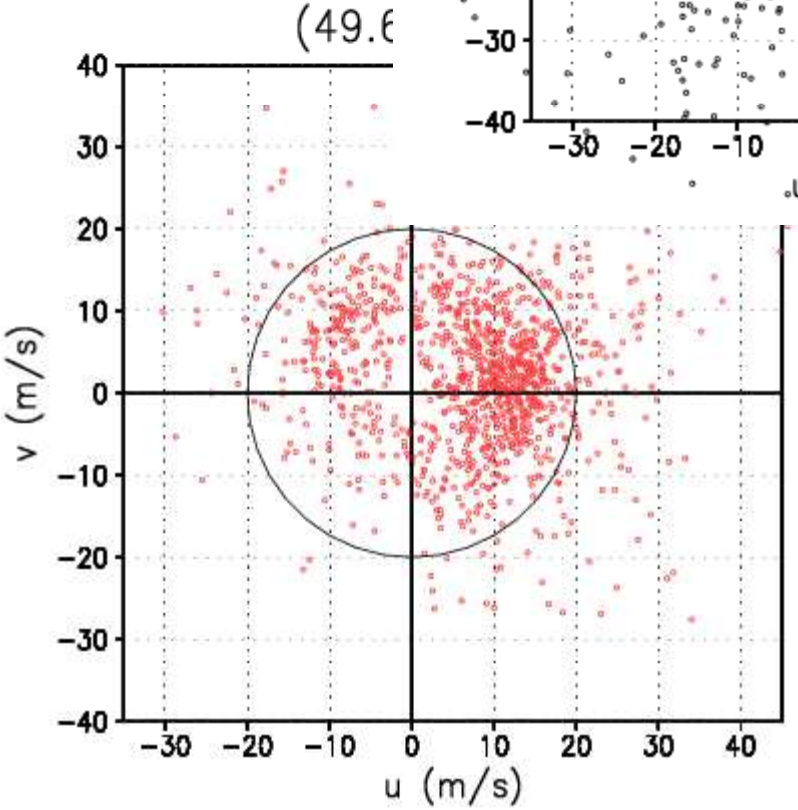

In the Fall of 1991,
the *Andrea Gail* left Gloucester, Mass.
and headed for the fishing grounds
of the North Atlantic.
Two weeks later, an event
took place that had never occurred
in recorded history.
A WOLFGANG PETERSEN FILM
THE
PERFECT STORM
WARNER BROS.


October 28, 1991


70N
65N
60N
55N
50N
45N
40N
35N
30N
25N
80W
70W
60W
50W
40W
30W
20W
10W
0
10E
20E
1
2
3
4
0
2
4
6
8
10


(59.6N, 42.9W)
v (m/s)
u (m/s)


(42.4N, 49.9W)
v (m/s)
u (m/s)


v (m/s)
u (m/s)

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